

AMENDMENTS

In the Claims

Current Status of Claims

- 1.(canceled)
- 2.(canceled)
- 3.(canceled)
- 4.(canceled)
- 5.(canceled)
- 6.(canceled)
- 7.(canceled)
- 8.(canceled)

- 1 9.(currently amended) The apparatus of claim ~~1~~28, further comprising:
- 2 _____ a nitrogen gas removal system filter connected to the oxidizing agent inlet to remove trace
- 3 amounts of nitrogen gas (N₂) in the oxidizing gas prior to the oxidizing agent entering the oxidizing
- 4 agent inlet of the combustion chamber.

- 10.(canceled)
- 11.(canceled)
- 12.(canceled)

- 1 13.(currently amended) The method of claim ~~21~~53, wherein the UV interference reduction
- 2 agent comprises a ~~NO~~ nitric oxide reactive species selected from the group consisting of ozone and
- 3 hydrogen peroxide.

- 14.(canceled)
- 15.(canceled)
- 16.(canceled)
- 17.(canceled)
- 18.(canceled)
- 19.(canceled)
- 20.(canceled)
- 21.(canceled)
- 22.(canceled)
- 23.(canceled)
- 24.(canceled)
- 25.(canceled)
- 26.(canceled)
- 27.(canceled)

1 28.(new) An apparatus for performing low level sulfur UV fluorescence detection comprising:
2 an oxidation or combustion chamber including:
3 a sample inlet,
4 an oxidizing agent inlet,
5 an oxidation zone, and
6 an oxidized sample outlet,
7 where the oxidation chamber is adapted to convert substantially all oxidizable components
8 of a sample into their corresponding oxides;
9 a transfer tube connected to the oxidized sample outlet adapted to transfer the corresponding
10 oxides to an UV chamber;
11 an UV interference reduction system adapted to introduce an UV interference reduction
12 agent into the sample before during and/or after oxidation, where the UV interference reduction
13 agent is capable of reducing or eliminating nitrogen oxides that interfere with sulfur UV
14 fluorescence detection; and
15 a detector/analyzer system including:
16 an excitation light source adapted to generate excitation light,
17 the UV chamber having:
18 an excitation light port in optical communication with the light source
19 adapted to excite SO₂ molecules in the oxidized sample into electronically
20 excited SO₂ molecules,
21 an oxidized sample inlet connected to the transfer tube,
22 an oxidized sample outlet for exhausting the oxidized sample from the
23 chamber after irradiation from the excitation light, and
24 a fluorescent light port oriented at an angle to the excitation light port, where
25 the angle is sufficient to reduce or eliminate excitation light from entering the
26 fluorescent light port;
27 a fluorescent light detector in optical communication with the fluorescent light port
28 adapted to detect fluorescent light emitted by the electronically excited SO₂
29 molecules passing through the fluorescent light port and to convert the detected
30 fluorescent light into an electrical output signal, and
31 an analyzer in electrical communication with the detector and adapted to convert the
32 electrical output signal into a concentration of sulfur in the sample,

33 where the UV interference reduction agent is introduced in an amount sufficient to convert
34 interfering nitrogen oxides into non-interfering nitrogen oxides thereby lowering a sulfur detection
35 limit to sulfur concentrations of less than 100 ppb.

1 29.(new) The apparatus of claim 28, wherein the amount of the UV interference reduction
2 agent is sufficient to lower the sulfur detection limit to sulfur concentrations below 50 ppb.

1 30.(new) The apparatus of claim 28, wherein the UV chamber further includes:
2 an optical filter associated with the fluorescent light port and
3 wherein the fluorescent light detector comprises a photo-multiplier tube (PMT).

1 31.(new) The apparatus of claim 28, wherein the oxidizing agent comprises an oxygen
2 containing gas selected from the group consisting of oxygen, oxygen in argon, ultra-pure oxygen,
3 ultra-pure oxygen in argon, or ultra-pure oxygen in ultra-pure argon.

1 32.(new) The apparatus of claim 28, wherein the UV interference reduction system comprises:
2 an ozone generator and
3 wherein the UV interference reduction agent comprises ozone.

1 33.(new) The apparatus of claim 32, wherein the ozone is introduced into the oxidizing agent
2 inlet of the combustion chamber.

1 34.(new) The apparatus of claim 32, wherein the ozone is introduced into the oxidizing zone
2 through an ozone inlet.

1 35.(new) The apparatus of claim 32, wherein the ozone is introduced into the combustion
2 chamber at its distal end through an ozone inlet.

1 36.(new) The apparatus of claim 32, wherein the ozone is introduced into the transfer tube
2 through an ozone inlet.

1 37.(new) The apparatus of claim 32, wherein the transfer tube includes:

an ozone chamber having an ozone inlet and
wherein the ozone is introduced into the ozone chamber through the ozone inlet.

38.(new) The apparatus of claim 32, wherein the UV chamber further includes:
a first sub-chamber having an ozone inlet and
wherein the ozone is introduced into the first sub-chamber through the ozone inlet.

39.(new) The apparatus of claim 32, wherein the ozone generator generates variable
concentrations of ozone to simultaneously minimize interfering nitric oxide fluorescence and ozone
absorption of excitation light and/or SO₂ fluorescent in the UV chamber.

40.(new) An apparatus for performing low level sulfur UV fluorescence detection comprising:
an oxidation or combustion chamber including:
a sample inlet,
an oxidizing agent inlet,
an oxidation zone, and
an oxidized sample outlet;
where the oxidation chamber is adapted to convert substantially all oxidizable components
of a sample into their corresponding oxides;
a transfer tube connected to the oxidized sample outlet adapted to transfer the corresponding
oxides to an UV chamber;
an ozone generator adapted to generate an ozone containing gas;
an ozone inlet adapted to introduce ozone into the sample before during and/or after
oxidation, where the ozone is capable of reducing or eliminating nitrogen oxides that interfere with
sulfur UV fluorescence detection; and
a detector/analyzer system including:
an excitation light source adapted to generate excitation light,
the UV chamber having:
an excitation light port in optical communication with the light source
adapted to excite SO₂ molecules in the oxidized sample into electronically
excited SO₂ molecules,
an oxidized sample inlet connected to the transfer tube,

an oxidized sample outlet for exhausting the oxidized sample from the chamber after irradiation from the excitation light, and a fluorescent light port oriented at an angle to the excitation light port, where the angle is sufficient to reduce or eliminate excitation light from entering the fluorescent light port; a fluorescent light detector in optical communication with the fluorescent light port adapted to detect fluorescent light emitted by the electronically excited SO₂ molecules passing through the fluorescent light port and to convert the detected fluorescent light into an electrical output signal, and an analyzer in electrical communication with the detector and adapted to convert the electrical output signal into a concentration of sulfur in the sample, where the ozone is introduced in an amount sufficient to convert interfering nitrogen oxides into non-interfering nitrogen oxides thereby lowering a sulfur detection limit to sulfur concentrations of less than 100 ppb.

42.(new) The apparatus of claim 40, wherein the amount of the ozone is sufficient to lower the sulfur detection limit to sulfur concentrations below 50 ppb.

43.(new) The apparatus of claim 40, further comprising: a nitrogen filter connected to the oxidizing agent inlet to remove trace amounts of nitrogen gas (N₂) in the oxidizing gas prior to the oxidizing agent entering the oxidizing agent inlet of the combustion chamber.

44.(new) The apparatus of claim 40, wherein the UV chamber further includes an optical filter associated with the fluorescent port and the detector comprises a photo-multiplier tube (PMT).

45.(new) The apparatus of claim 40, wherein the oxidizing agent comprising an oxygen containing gas selected from the group consisting of oxygen, oxygen in argon, ultra-pure oxygen, ultra-pure oxygen in argon, or ultra-pure oxygen in ultra-pure argon.

46.(new) The apparatus of claim 40, wherein the ozone is introduced into the oxidizing agent inlet of the combustion chamber.

1 47.(new) The apparatus of claim 40, wherein the ozone is introduced into the oxidizing zone
2 through an ozone inlet.

1 48.(new) The apparatus of claim 40, wherein the ozone is introduced into the combustion
2 chamber at its distal end through an ozone inlet.

1 49.(new) The apparatus of claim 40, wherein the ozone is introduced into the transfer tube.

1 50.(new) The apparatus of claim 40, wherein the transfer tube includes:
2 an ozone chamber having an ozone inlet and
3 wherein the ozone is introduced into the ozone chamber through the ozone inlet.

1 51.(new) The apparatus of claim 40, wherein the UV chamber further includes:
2 a first sub-chamber having an ozone inlet and
3 wherein the ozone is introduced into the first sub-chamber through the ozone inlet.

1 52.(new) The apparatus of claim 40, wherein the ozone generator generates variable
2 concentrations of ozone to simultaneously minimize interfering nitric oxide fluorescence and ozone
3 absorption of excitation light and/or SO₂ fluorescent in the UV chamber.

1 53.(new) A method for improving low level sulfur detection using UV fluorescent
2 spectrometry, comprising the steps of:

3 introducing a sample and sufficient oxidizing agent to completely oxidize all oxidizable
4 sample components into their corresponding oxides into a combustion chamber for a time and at an
5 elevated temperature sufficient to convert substantially all oxidizable components into their
6 corresponding oxides to produce an oxidized sample; and

7 introducing an UV interference reduction agent into the sample prior to sulfur detection,
8 where the UV interference reduction agent is capable of converting nitrogen oxides formed during
9 sample oxidation in the combustion chamber that interfere with sulfur detection into nitrogen oxides
10 that do not interfere with sulfur detection to produce a modified oxidized sample,

11 forwarding the modified oxidized sample to an UV chamber,

12 irradiating the modified oxidized sample with excitation light to form electronically excited
13 SO₂ molecules in the UV chamber,
14 detecting fluorescent light emitted by the electronically excited SO₂ molecules in the UV
15 chamber, and
16 converting the detected fluorescent light into a concentration of sulfur in the sample,
17 where the UV interference reduction agent is introduced in an amount sufficient to reduce
18 a sulfur detection limit to sulfur concentration levels below 100 ppb.

1 54.(new) The method of claim 53, wherein the UV interference reduction agent is present in
2 an amount sufficient to reduce sulfur detection limits to sulfur concentration levels below 50 ppb.

1 55.(new) The method of claim 53, wherein the oxidizing agent comprises an oxygen, oxygen
2 in argon, ultra-pure oxygen, ultra-pure oxygen in argon, or ultra-pure oxygen in ultra-pure argon.

1 56.(new) The method of claim 53, further comprising the step of:
2 contacting the oxidizing agent with a nitrogen gas removal reagent to reduce or eliminate
3 nitrogen gas present in the oxidizing agent prior to introducing the oxidizing agent into the
4 combustion chamber.

1 57.(new) The method of claim 56, wherein the UV interference reduction agent comprises
2 ozone.

1 58.(new) The method of claim 57, further comprising the step of:
2 adjusting the ozone concentration to simultaneously minimize interfering NO fluorescence
3 and ozone absorption of excitation light and/or SO₂ fluorescent light during SO₂ fluorescence
4 detection.

1 59.(new) The method of claim 57, wherein the ozone is introduced into the oxidizing agent.

1 60.(new) The method of claim 57, wherein the ozone is introduced into the oxidizing sample.

1 61.(new) The method of claim 57, wherein the ozone is introduced into the oxidized sample.

